# PATENT ABSTRACTS OF JAPAN

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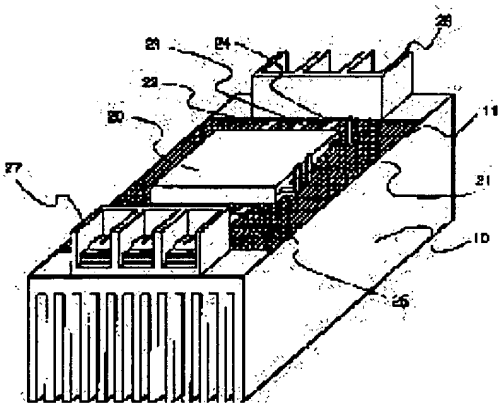
## (54) POWER MODULE INTEGRATING HEAT RADIATING FIN

(57)Abstract:
PROBLEM TO BE SOLVED: To reduce and equalize thermal resistance by heat-bonding a power module to a heat radiating fin with insulating resin of high thermal conductivity.
SOLUTION: A power semiconductor element 14 is soldered to a metal plate 12 for heat diffusion forming the bottom surface of a power module 20. Moreover, a control terminal 21, extending from the power module 20, is connected to a control circuit loaded on the printed circuit board. Moreover, an external 3-phase input terminal 26 and an external 3-phase output terminal 27 are fixed on the heat radiating fin 10 by the screwing or with bonding agent and are then connected to the power module 20 via bus bar wirings 22, 23, 24, 25. Then the power module 20 is heat-bonded to the heat radiating fin 10 with an insulated resin sheet 11. That bonding condition is set at 5 kgf/cm2 and for 3 minutes at 151.9°C. This insulating resin sheet 11 is bisphenol A type epoxy resin which includes 71.3 wt.% of alumina filer ($\alpha$-Al2O3). As a result, thermal resistance can be reduced and equalized.



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CLAIMS

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[Claim(s)]
[Claim 1] It is the radiation-fin one apparatus power module characterized by to insulate electrically with the insulating resin sheet with which said power circuit section and said radiation fin contained the ceramics in the radiation-fin one apparatus power module equipped with the external-I/O terminal connected to the power circuit section equipped with the power semiconductor device, the control circuit section which controls this power circuit section, and said power circuit section and the control circuit section, and the heat sink which has irregularity in a front face and the so-called radiation fin.
[Claim 2] It is the radiation-fin one apparatus power module characterized by the ceramics in said insulating resin sheet using at least one kind in alpha-aluminum 2O3, AlN, SiC and SiO2, and MgO in a power module according to claim 1.
[Claim 3] It is the power module characterized by the principal component of said insulating resin sheet being the bisphenol A mold epoxy resin in a power module according to claim 1.
[Claim 4] Setting to a power module according to claim 1, the thickness of said insulating resin sheet is 0.15mm substantially. Radiation-fin one apparatus power module characterized by being the following.
[Claim 5] It is the radiation-fin one apparatus power module characterized by the content of the alumina filler of said insulating resin sheet being 65% or more in a weight ratio in a power module according to claim 2.
[Claim 6] It is the radiation-fin one apparatus power module characterized by for said power circuit section carrying a power semiconductor device on a leadframe in a power module according to claim 1, and constituting.
[Claim 7] It is the radiation-fin one apparatus power module which the closure is carried out to the package by which transfermold was carried out by said power circuit section using a leadframe as a base in claim 1 thru/or a power module given in six, and is characterized by insulating this package base and said radiation fin electrically with said insulating resin sheet.
[Claim 8] It is the radiation-fin one apparatus power module characterized by for said power circuit section using said radiation fin as a base in a power module according to claim 1, and carrying out transfermold with said insulating resin sheet.
[Claim 9] It is the radiation-fin one apparatus power module which said external-I/O terminal is the technique of adhesion by adhesives, a screw stop, etc. in the radiation-fin one apparatus power module equipped with the external-I/O terminal connect to the power circuit section equipped with the power semiconductor device, the control circuit section which controls this power circuit section, and said power circuit section and the control circuit section, and the heat sink which has irregularity in a front face and the so-called radiation fin, and is characterize by to be fix to said radiation fin.
[Claim 10] The power circuit section equipped with the power semiconductor device, and the control circuit section which controls this power circuit section, In the manufacture approach of the radiation-fin one apparatus power module equipped with the external I/O terminal connected to said power circuit section and the control circuit section, and the heat sink which has irregularity in a front face and the so-called radiation fin The manufacture approach of the radiation-fin one apparatus power module characterized by pasting up said power circuit section and said radiation fin, and insulating electrically by pressurizing inserting and heating said insulating resin sheet containing the ceramics between said power circuit sections and said radiation fins.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the structure which realizes low-fever resistance-ization of a power module and raises dependability in the power module which constitutes power converters, such as an inverter, especially an IGBT (Insulated Gate Bipolar Transistor) module.
[0002]
[Description of the Prior Art] The mimetic diagram which omitted the control circuit substrate in which the microcomputer of conventional small capacity inverter equipment etc. was carried is shown in drawing 4 . The so-called insulating mold module 40 with which the power semiconductor device and the heat sink were insulated is being fixed through grease 31 on the radiation fin 30. There are what used the ceramic substrates (AlN etc.) 35 for the insulating material as a internal structure of this insulating mold module 40 as shown in drawing 3 (a), and a thing which used the insulating metal substrate 307 as shown in drawing 3 (b).
[0003] the heat dissipation which constitutes a module base from drawing 3 (a) -- public funds -- the ceramic substrate 35 for an insulation is soldered on the group base 32, and the power semiconductor device 38 is soldered on it. The metallic foils 34 and 36 for soldering are components beforehand pasted up on the ceramic substrate 35 by technique, such as thermocompression bonding or soldering, and the metallic foil 36 has also played the role of the substrate for energization connected with a main terminal and a control terminal.
[0004] In drawing 3 (b), it has the structure where the metal plate 306 for thermal diffusion and the power semiconductor device 38 were soldered on the insulating metal substrate 307. the heat dissipation whose insulating metal substrate 307 has the insulating resin layer 303 on a front face -- public funds -- it has the structure which the metallic foil 304 pasted up on the group base 302, and the metallic foil 304 has also played the role of the substrate for energization connected with a main terminal and a control terminal.
[0005] Since the thermal resistance of the insulating resin layer 303 of drawing 3 (b) is larger than that of the ceramic substrate 35 of drawing 3 (a), the structure of drawing 3 (b) is used for a power module with small current capacity compared with drawing 3 (a). Drawing 3 (a) and (b) are using grease for fixing a power module to a radiation fin 30, and the solder layer is two-layer [ of the power semiconductor device 38, the solder 37 for adhesion and the ceramic substrate 35, the solder 33 for adhesion or the thermal diffusion plate 306, and the solder 305 for adhesion ].
[0006]
[Problem(s) to be Solved by the Invention] The above-mentioned conventional structure has the problem of the following [ the field of module dependability ].
[0007] As shown in drawing 3 for high currents (a), and drawing 3 for below current capacity abbreviation 50A (b), grease 31 is used for both structures fixing the power module 40 to a radiation fin 30 conventionally. Grease 31 is indispensable in order to prevent heat insulation with the air which exists between the power module 40 and a radiation fin 30. However, applying to homogeneity has the trouble that it is difficult and dispersion in heat will arise in a spreading side. Moreover, spreading of grease has bad workability and the rise of equipment assembly cost is brought about. Furthermore, in the heat dissipation system, even if grease is a high temperature resisting medium and it can apply solder etc. thinly (for example, about 50mm) compared with other matter, in the thermal resistance of the whole equipment, it is dominant and has become the cause of main of the temperature rise of equipment. And since the current which will flow if a module is large-capacity-ized becomes large and generation of heat of a chip also becomes large, the problem of the thermal resistance of grease will become serious, and as for large-capacity-izing, a module will mean becoming large, and dispersion within a field will also become remarkable.
[0008] This invention is made in consideration of a trouble which was mentioned above, realizes low-fever resistance-

ization of a power module, and aims at offering the power module of high reliance.
[0009]
[Means for Solving the Problem] This invention is made in view of the trouble of structure conventionally [ above-mentioned ], and does not carry out thermocompression bonding of the power module to a radiation fin with the insulating resin sheet 11, and the big description is in the place which does not use grease. As for this insulating resin sheet, it is desirable that it is high temperature conductivity.
[0010] Since according to this invention thermocompression bonding of the power module is carried out to the radiation fin with the insulating resin sheet and it can reduce and equalize thermal resistance instead of using grease, high reliance-ization is realizable.
[0011]
[Embodiment of the Invention] The example of this invention is explained to a detail below using a drawing.
[0012] It will become drawing 1 if the heat dissipation system inside the power module 20 is shown typically. It has the structure which soldered the direct power semiconductor device 14 on the electrode (metal plate for thermal diffusion) 12 which constitutes a power module base, and has become a non-insulating mold package. That is, the insulating resin sheet 11 serves both as a radiation fin 10, an insulation of the power semiconductor device 14, and heat dissipation. The component required for inverters, such as the converter section (six diodes) and the inverter section, is carried in the power module 20.
[0013] First, a basic configuration is explained using drawing 2 . Thermocompression bonding of the power module 20 is carried out to the radiation fin 10 with the insulating resin sheet 11. The conditions of thermocompression bonding are 2,151.9 degree C 5 kgf/cm. It is for 3 minutes. This insulating resin sheet 11 is for example, an alumina filler (alpha-aluminum 2O3) 71.3wt(s)% Although the included bisphenol A mold epoxy resin is used, AlN, SiC, SiO2, and a MgO filler are sufficient. As shown in drawing 1 , the power semiconductor device 14 is soldered on the metal plate 12 for thermal diffusion which makes the base of the power module 20, and the control terminal 21 extended from the power module 20 is connected to the control circuit carried in the printed circuit board (with no illustration) allotted to the upper part of drawing 2 . On a radiation fin 10, the external three-phase-circuit input terminal (R, S, T) 26 and the external three-phase-circuit output terminal (U, V, W) 27 **** independently, and it is fixed with a stop or adhesives, and is connected with the power module 20 with the busbar wiring 22, 23, 24, and 25. The leadframe (it is the same as busbar wiring) serves as the thermal diffusion plate 12, and the thickness is about 1mm. Moreover, as for this structure, only one layer uses solder.
[0014] By not using grease, at the time of the same gestalt, the thermal resistance of the whole equipment is falling sharply compared with 0.54 degrees C/W and 0.73 degrees C/W of drawing 3 (b), and is 0.58-degree-C/[ of drawing 3 (a) ] W. The good value is acquired. Thus, since thermal resistance is small, the width of face of a radiation fin and a number can be made small, and it has the operation which can attain the miniaturization of equipment. Moreover, high currents have an operation of being usable.
[0015] The example about the power module which carries out a resin seal including a radiation fin is shown in drawing 5 . The basic structure of the cross section of drawing 5 is the same as drawing 1 . Thermocompression bonding of the leadframe 53 is carried out to the radiation fin 10 with the insulating resin sheet 11, and the power semiconductor device 14 is soldered on it. The transfermold of the power semiconductor device 14, solder 13, a leadframe 53, the insulating resin sheet 11, and the radiation fin 10 is collectively carried out by epoxy system resin 50. Wirebonding of between the power semiconductor device 14, and a gate terminal 51 and a main terminal 52 is carried out with aluminum wire.
[0016] The example which carried out the transfermold of the converter part and inverter part of inverter equipment separately is shown in drawing 6 . On the radiation fin 10, thermocompression bonding of the converter 60 and inverter 61 by which transfermold was carried out separately is carried out with the insulating resin sheet 11.
[0017] The busbar wiring 62, 63, and 64 has led to the converter 60 from the external input terminal 26. It is connected in two, the P wiring 65 and the N wiring 66, between the converter 60 and the inverter 61, and the inverter 61 is connected with the external output terminal 27 and busbar wiring. Moreover, the control terminal 67 is connected to the control circuit on the printed circuit board (with no illustration) allotted to the upper part of drawing 6 .
[0018] Here, a converter 60 and an inverter 61 can be arranged in the location of the arbitration on the thermocompression bonding sheet 11 as other examples. Moreover, carrying out the transfermold of the brake phase part, and carrying on the thermocompression bonding sheet 11 is also considered. Furthermore, arranging one converter and two inverters on the thermocompression bonding sheet 11 or carrying the external input terminal 26 and the external output terminal 27 on a printed circuit board (with no illustration) are also considered.
[0019] The example which carried the inverter part and the converter part on the radiation fin separately is shown in drawing 7 . Drawing 7 (a) is the structure before mounting the printed circuit board 702 shown by drawing 7 (b), and

drawing 7 (b) is the structure after mounting a printed circuit board 702.
[0020] Thermocompression bonding of the converter 70 and inverter 71 by which transfermold was carried out, respectively is carried out with the insulating resin sheet 11 on two fins 10. The converter 70 is connected with the external input terminal 26 and the busbar wiring 72, 73, and 74. It is connected in two, the P wiring 75 and the N wiring 76, between the converter 70 and the inverter 71, and it has structure which the terminals 77, 78, and 79,700 extended from the converter 70 and the inverter 71 insert. The inverter 71 and the external output terminal 27 are connected with busbar wiring (with no illustration), and the control terminal 701 of an inverter 71 is connected to the printed circuit board 702 in which the driver IC 703 grade was carried. The P wiring 75 and the N wiring 76 are being fixed by the printed circuit board 702.
[0021] Here, a converter 70 and an inverter 71 can be arranged to arbitration on the thermocompression bonding sheet 11 as other examples. Moreover, carrying out the transfermold of the brake phase part, and carrying on the thermocompression bonding sheet 11 or arranging one converter and two inverters on the thermocompression bonding sheet 11 are also considered.
[0022] It is mentioned that the width of face and the number of radiation fins are very small, and end by sharp reduction of thermal resistance as a description of this invention in the case of small capacity inverter equipment. Therefore, it is not necessary to use a radiation fin as susceptor of inverter equipment like an old example. The example in this case is shown in drawing 8 .
[0023] In drawing 8 , the power module 81 and the printed circuit board 80 are connected with the control terminal and the main terminal 82. On the printed circuit board 80, the external input terminal 26, the external output terminal 27, the smoothing capacitor 83, the transformer 84, the transistor 85, the driver IC 86, etc. are carried.
[0024] Here, it is possible to carry two or more radiation-fin one apparatus power modules 81 on a printed circuit board 80, and to control by the driver IC 86 to coincidence as other examples. Moreover, the power module 81 can be arranged in the location of the arbitration on a printed circuit board 80.
[0025] Drawing 9 is used and the example of others of the closure method of the resin of a power module is explained. Instead of carrying out transfermold with resin 50 by drawing 5 , potting of a radiation fin 10, the insulating resin sheet 11, a leadframe 53, solder 13, and the power semiconductor device 14 is carried out by resin 90 by drawing 9 .
[0026]
[Effect of the Invention] According to this invention, it is effective in thermocompression bonding of the power module being carried out to the radiation fin with the insulating resin sheet instead of grease, and an activity being simplified and being able to realize high reliance-ization, since there is also a solder layer.
[0027] Furthermore, by not using grease, it becomes possible to be able to reduce the thermal resistance of the whole equipment sharply, consequently to make very small the width of face of a radiation fin, and a number, and it has the effectiveness that the miniaturization of equipment can be attained.

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DRAWINGS

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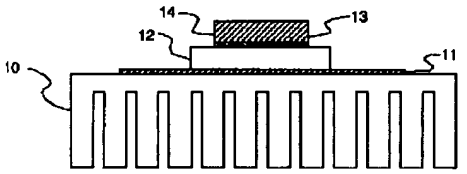
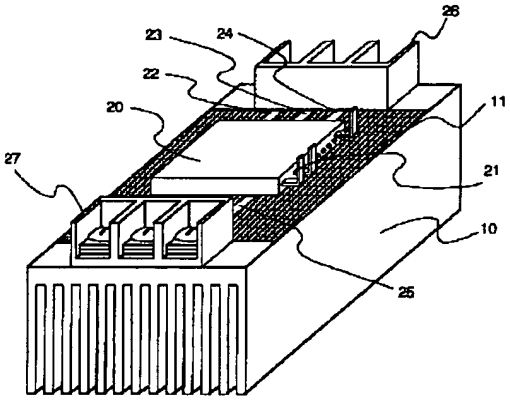
[Drawing 1]

図 1




[Drawing 2]

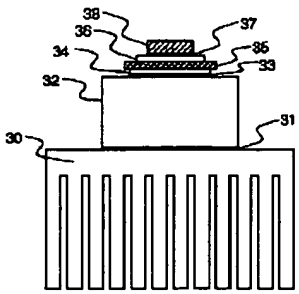
図 2




[Drawing 3]

図 3

(a)

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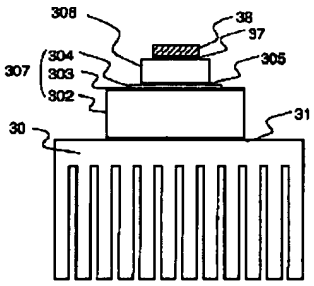
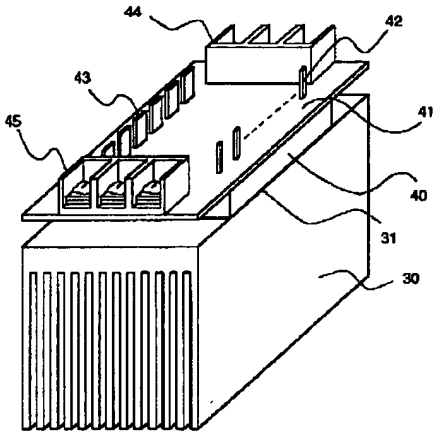


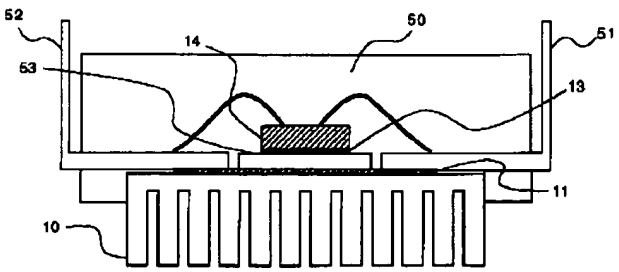

[Drawing 4]

図 4



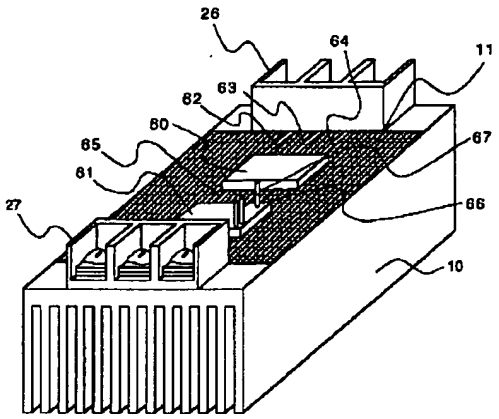

[Drawing 5]

図 5



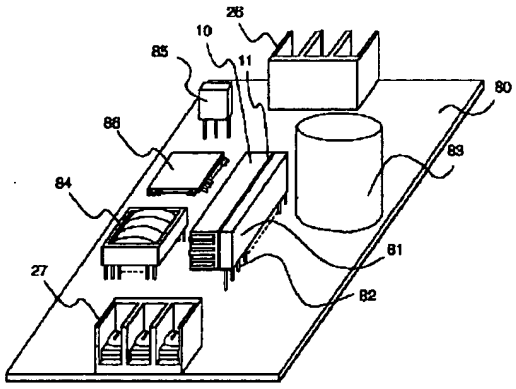

[Drawing 6]

図 6



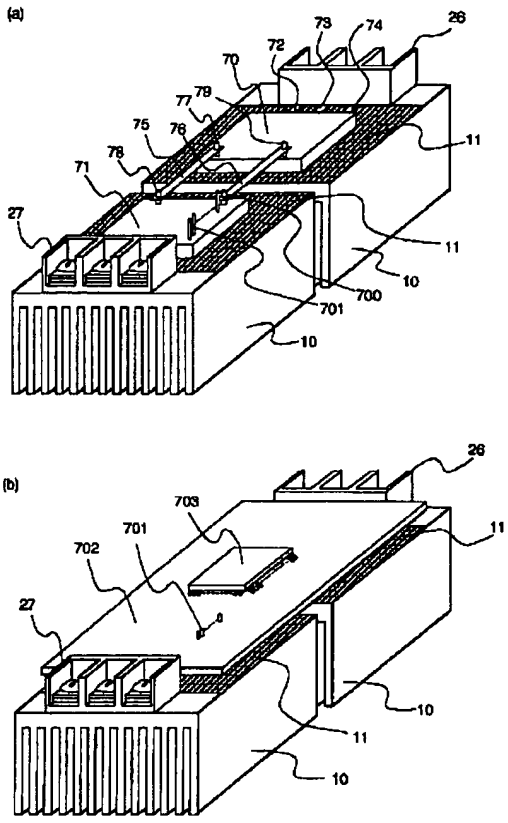

[Drawing 8]

図 8



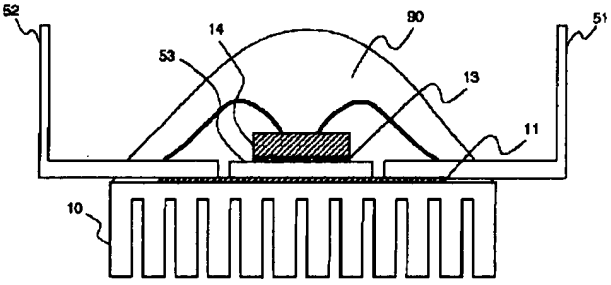

[Drawing 7]

図 7




[Drawing 9]

図 9

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